WETTABILITY OF ACTIVATED BY VARIOUS MEANS GRAPHITE BY WATER–BASED SYSTEMS

Kovaleva Angelina A., Gilmanshina Tatiana R., Deaconova Vera Y., Lytkina Svetlana I., Khudonogov Sergey A., Abkarian Arthur K., Masanskii Oleg A., Kaposko Inga A.

Siberian Federal University, Krasnoyarsk, Russian Federation
E-mail: gtr1977@mail.ru

ANNOTATION
The formation of a high-quality casting surface is a complex process, determined by the nature of an alloy filling, heating the mold, physicochemical and mechanical interaction of the melt with the atmosphere of the mold, in the contact zone material-mold. On the one hand, the filler of the antipenetration wash should not be wetted by alloys, on the other hand, to form properties in the liquid state, the filler should be well wetted by a solvent. At present, the most common solvent used in the antipenetration wash is water. The purpose of this work is to study wettability of graphite activated by various methods i.e. by water and water –based systems . In the course of the process it was found that activated GKM is wetted by water worse (wetting angle is 90–120° depending on the method of preparing GKM than natural graphite (wetting angle of water is 55°). It was revealed that activated graphite is better wetted by water-based binding systems: depending on the activation method (mechanical, chemical and chemical-mechanical) the wetting graphite angle by 10% LST solution decreases from 49 to 37°; by 3.5% water bentonite slurry - from 69 to 50°; by water-based binding system containing 10% LST and 3.5% bentonite - from 54 to 40º.

KEYWORDS
Graphite, mechanical activation, chemical activation, multimeter activation methods, wettability

INTRODUCTION
The formation of a high-quality casting surface is a complex process, determined by the nature of an alloy filling, heating the mold, physicochemical and mechanical interaction of the melt with the atmosphere of the mold in the contact zone material-mold. [1–7].
On the one hand, the filler of the antipenetration wash should not be wetted by metals, on the other hand, to form properties in the liquid state, the filler should be well wetted by a solvent. [8--14].
In the liquid state at the time of preparation and application, the antipenetration wash is a complex colloidal system, therefore, its properties should be studied taking into account modern physicochemical concepts of the interaction of the dispersed phase (graphite as suspension filler) and the dispersion medium (water, alcohol) as a system in general. An equidistribution of graphite particles in a solvent (water, alcohol, etc.) can be achieved while ensuring a high sedimentation stability of the suspension, which is primarily determined by the colloid-chemical properties of the "graphite-solvent system": graphite particles wettability by the solvent, dispersion, imperfection and surface state of graphite particles. All these parameters to a great extent depend on the method of preparing and activating graphite [11, 13, 14–17, etc.].
At present, the most common solvent used in the antipenetration wash is water.
Therefore, the purpose of this work is to study the wettability of graphite activated by various means by water and water-based systems.

MATERIAL AND METHODS
Natural cryptocrystalline graphite (GFC-2) was chosen for the research. In order to increase the graphite activity, it was subjected to mechanical (GFC-2), chemical (GFC-2O) and chemical-mechanical (GFC-2OA) activations.
For the mechanical graphite activation, the equipment "RETSCH PM 400 MA" installed in the Laboratory of Dispersed and Nanostructured Solid, Viscous and Colloidal Materials of the Siberian Federal University was used.
Chemical activation was performed according to the persulfate scheme [18–21].
The wettability of graphite by water and water-based systems was determined by the sessile drop method, the calculation of the coefficients was determined by the method described in [22].

RESULTS AND DISCUSSION
The wettability of natural graphite and activated by various methods graphite by water is shown in Fig. one.

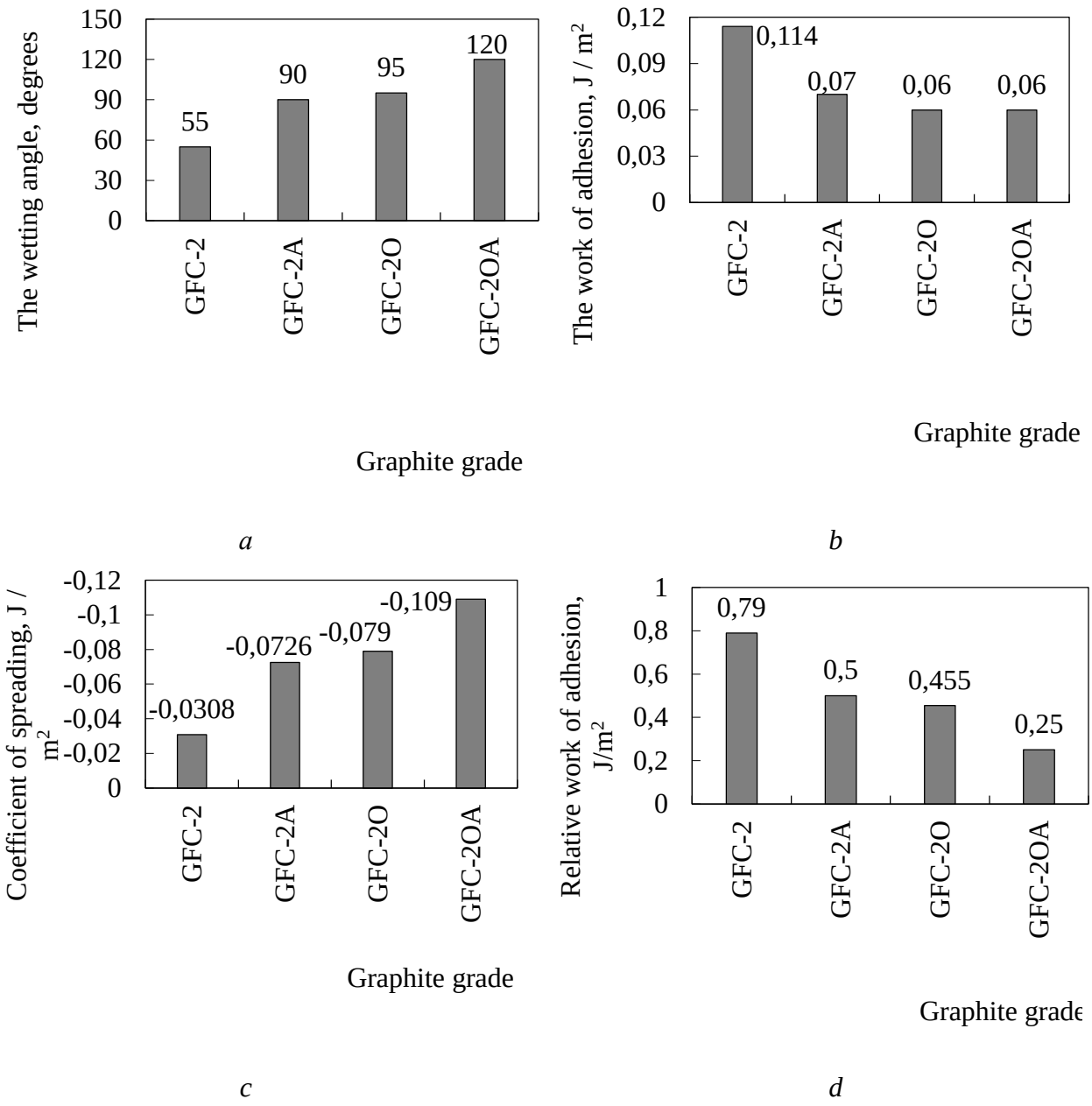

Fig.1. Activated in various means graphite wettability by water
a - the wetting angle, *b* - the work of adhesion,
c - coefficient of spreading, *d*- relative work of adhesion

Activated graphite is wetted by water worse than natural graphite. This is due to the fact that when using GFC-2A as a graphite substrate, the roughness of samples based on them is 2 μm (the roughness of a sample made from natural graphite is 2.6 μm) due to the prevalence in activated graphite elongated irregular and acute-angular shapes of particles formed in the process of mechanical activation. When pressed, these particles are packed up in such a way that the protrusions on the surface are turned "peaks" to the outside. This dramatically reduces the contact area between the graphite surface of and water.

On the one hand, on the surface of chemically activated graphite GFC-2O, sulfo groups and other oxygen-containing functional groups are present, contributing to an increase of the graphite wetting. On the other hand, the presence of enlarged interplanar distance creates microporosity, which reduces the water wettability of graphite GFC-2O.

In the case of using graphite GFC-2OA, the roughness of the particles, and the presence of sulfo groups on their surface will influence the reducing of wettability.

For the research, we chose the water antipenetration wash of the composition, wt%: graphite — 58.5; bentonite — 3.5; lignosulfonate technical (LST) —10; water - up to 100 [23].

At this stage of work, the wettability of graphite-binding compositions was investigated: 10% aqueous solution of LST; 3.5% aqueous bentonite suspension; water composition containing 10% LST and 3.5% bentonite.

The surface tension of these compositions is shown in Fig. 2

The surface tension of water, which has a rather large intermolecular interaction due to the presence of hydrogen bonds, is 72.4 mJ / m^2. The addition of LST (produced by Krasnoyarsk pulp and paper mill) and bentonite to water leads to a decrease of intermolecular interaction and, consequently, to a decrease in surface tension to 72.1 mJ / m^2 (for LST solution) and 71.9 mJ / m^2 (for bentonite suspension).

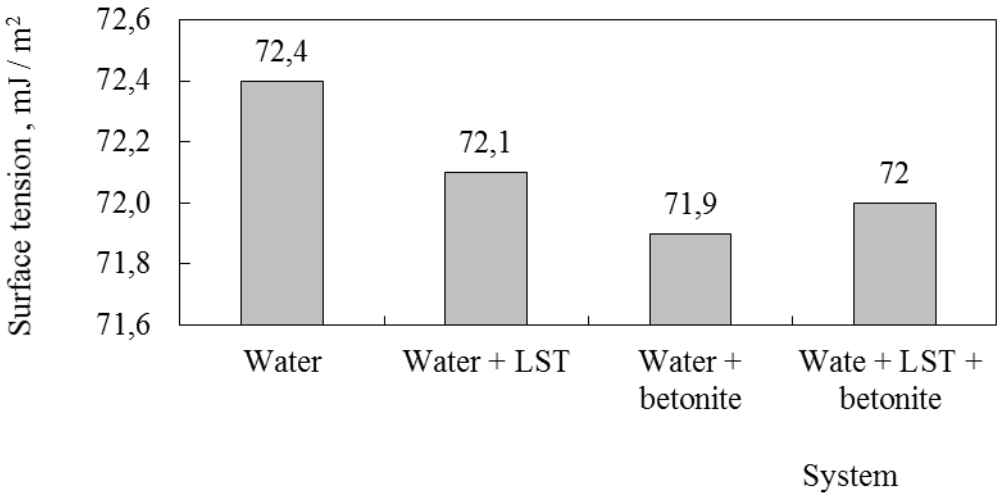

Fig. 2. Surface tension of water-based binding composition

The wettability of natural and activated graphite by water-based binding systems which are included into the antipenetration wash composition is shown in Fig. 3–6.

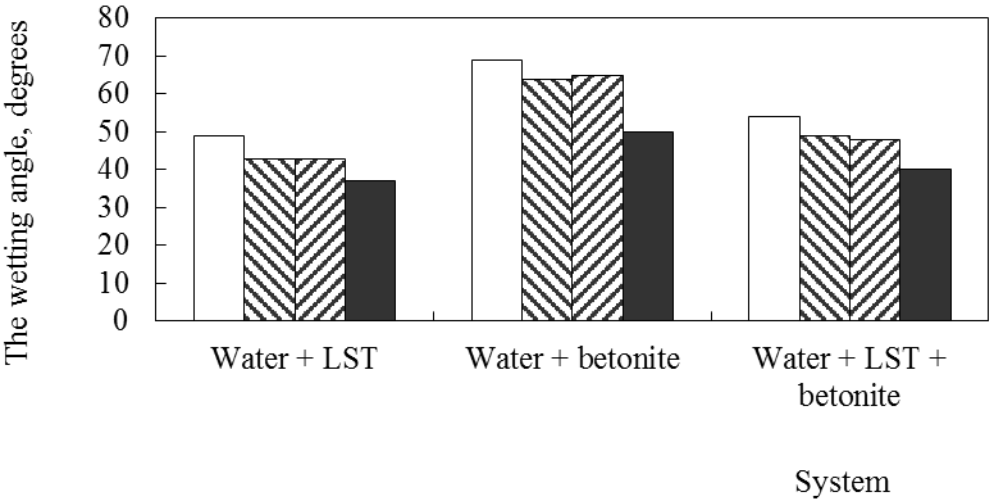

Fig. 3. Wetting angle of graphite
(□ - GFC-2; ▨ - GFC-2A; ▨ - GFC-2O; ■ - GFC-2OA)
water-based binding system

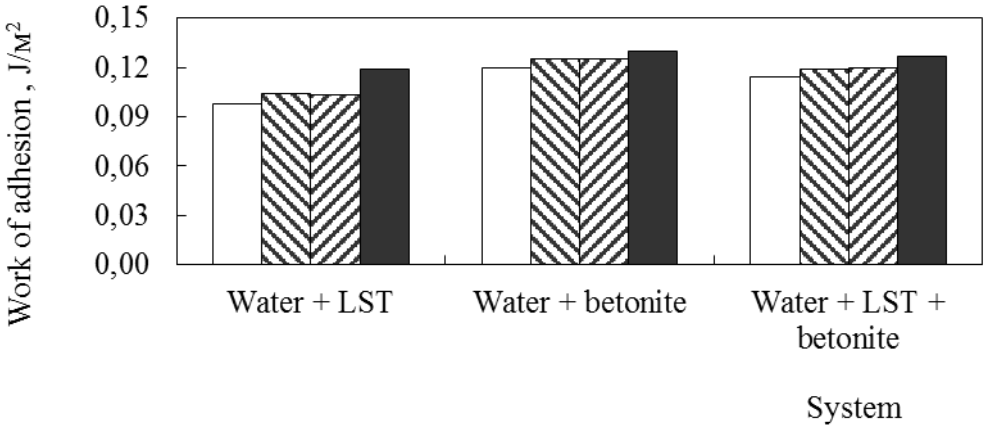

Fig. 4. Work of adhesion on the graphite border (□ - GFC-2; ▧ - GFC-2A; ▨ - GFC-2O; ■ - GFC-2OA) water-based binding system

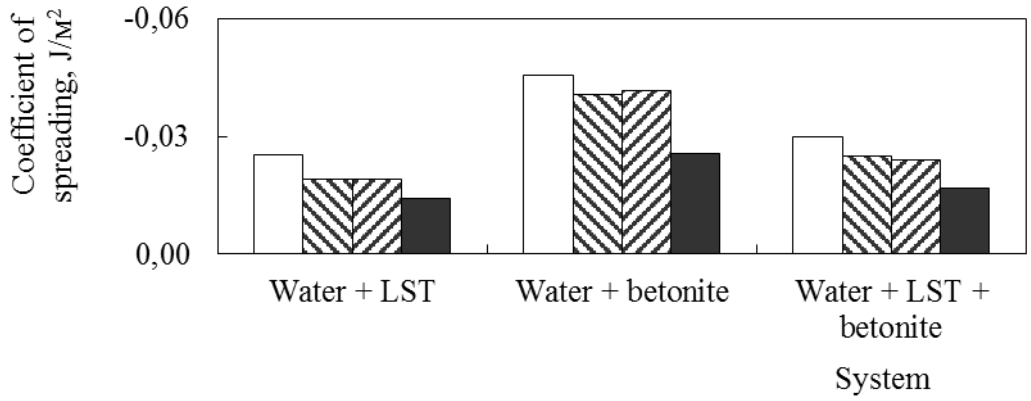

Fig. 5. The coefficient of included in the coating composition spreading along graphite (□ - GFC-2; ▧ - GFC-2A; ▨ - GFC-2O; ■ - GFC-2OA)

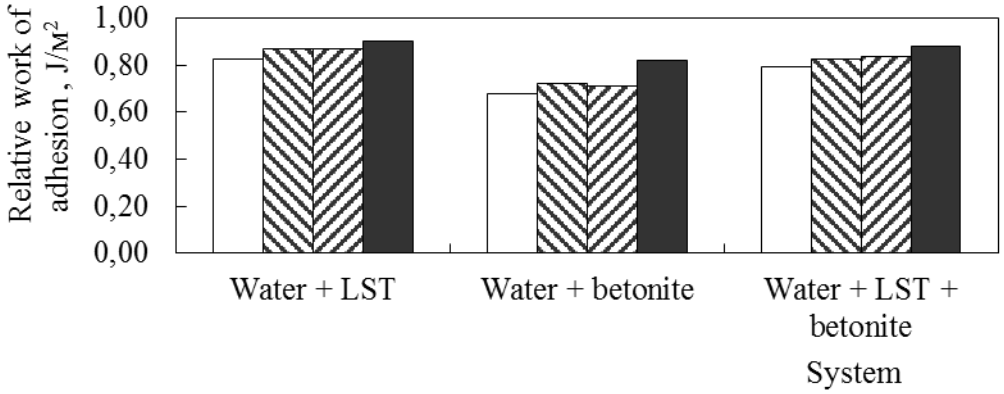

Fig. 6. Relative work of adhesion on the graphite border(□ - GFC-2; ▧ - GFC-2A; ▨ - GFC-2O; ■ - GFC-2OA) - water-based binding system

When interacting, in the solution LST- graphite LST molecules are located on the surface of graphite with the formation of a layer in which the molecules are oriented (the polar part is directed to a polar medium, and the non-polar is non-polar), thereby reducing the hydrophobicity of the surface of graphite particles. The wetting graphite angle in this case decreases from 55 to 49°.

The use of various methods for the activation of graphite leads to an increase in the thickness of the adsorption-solvation layer, as a result of which the wettability of activated graphite is much higher than of the natural one. The wetting angle is reduced from 49 to 43 ° for mechanically and chemically activated graphite and to 37 ° for chemically and mechanically activated graphite.

The addition of bentonite to water leads to an increase of the natural graphite wetting angle from 55 to 69 °. When slurry is applied, the particles of bentonite are located between the particles of graphite, forming the microroughness of the sample, which reduces wettability. Changing the state of the surface and the size of graphite particles in the activation process provides a more dense packing of the particles in the process of making the sample. In this case, the particles of bentonite will be located on the surface of the graphite sample, thereby “leveling” it and increasing the hydrophilicity. Wetting angle for graphite GFC-2A and GFC-2O decreases to 64–65 and to 50 ° for GFC-2OA.

The study of wettability by the liquid binding composition, including water, LST and bentonite, showed that the wetting angle for natural graphite is equal to the wetted by water graphite angle. In the case of activated graphite, it decreases (to 40–49°) due to the fact that LST and bentonite reduce the surface tension of water, thereby playing the role of surface-active substances.

CONCLUSIONS

It is shown that activated GKM is wetted by water worse (wetting angle is 90–120° depending on the method of preparing GKM) than natural graphite (wetting angle of water is 55°). It was revealed that activated graphite is better wetted by water-based binding systems: depending on the activation method (mechanical, chemical and chemical-mechanical) the

wetting graphite angle by 10% LST solution decreases from 49 to 37°; by 3.5% water bentonite slurry - from 69 to 50°; by water-based binding system containing 10% LST and 3.5% bentonite - from 54 to 40º.

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